PATENT SPECIFICATION

Application Date: July 23, 1934. No. 21562/34. 442.008

Complete Specification Left: Nov. 10, 1934.

Complete Specification Accepted: Jan. 23, 1936.

PROVISIONAL SPECIFICATION

Method of and Apparatus for Recovering Water from or Supplying Water to Subterranean Formations

I, LEO RANNEY, a citizen of the United States of America, of Petrolia, Ontario, Canada, do hereby declare the nature of this invention to be as follows:—

This invention relates to methods of and installations for recovering water from subterranean formations or for replenishing or supplying the subterranean formations with water, and the invention has for its object to provide improved methods and installations for carrying this out effectively and economically.

The invention comprises an installation for the recovery of water from or for the supply of water to a subterranean formation comprising a shaft extending into the subterranean formations and affording access to the latter at a plurality of points and means for individually controlling the withdrawal or supply of water from or to such points of access.

The invention also comprises an installation according to the preceding paragraph wherein each means of access to the subterranean formations is provided with means for back-washing the same for cleansing purposes.

The invention also comprises an installation according to either of the two preceding paragraphs wherein the said means consist of perforated tubes projected radially with respect to the axis of the shaft.

The invention also comprises an installation according to the preceding paragraph wherein an imperforate tube is provided for insertion within each perforated tube in order to remove the fine material delivered to the interior of the imperforate tube during the projecting operation said imperforate tube communicating, at one end thereof, with a boring head at the forward end of the perforated tube, and, at its other end, with the interior of the shaft into which the fine material may be discharged.

The invention also comprises an installation according to the preceding paragraph wherein means is provided for maintaining a fluid-tight joint between the two tubes of each said access means.

Such sealing means may consist of a sleeve slidable upon the imperforate tube and carrying one or more resilient elements adapted to engage with the interior surface of the perforated tube in a fluid-tight manner.

The invention also comprises an improved boring head for use in projecting a water supply or discharge tube into a subterranean formation wherein the boring head is of hollow formation and is slotted to permit the fine material encountered during the boring operation to pass through the openings into the interior of the boring head for ultimate removal therefrom.

The slots in the boring head may be bounded upon their longitudinal sides by longitudinal ridges projecting from the outer surface of the boring head and these sides of the slots may be inclined so that the slots become gradually wider towards the interior of the head and also become gradually wider towards the end thereof remote from the leading end of the boring head where each slot may be formed with an inclined surface which tends to lift any stones or oversize material which may roll along the slots as the boring head is advanced and which are encountered by this inclined surface during such advancement. The boring head may also be formed with further slots more distant from the leading end of the boring head. These further slots also communicate with the interior of the boring head and each slot may be directly preceded by an inclined projection on the outside surface of the boring head which serves to lift the gravel or the like as the boring head is advanced. The rear end of each slot may also be formed with an inclined surface as in the case of the first mentioned slots.

The invention also comprises a method of projecting a perforated screening tube into a subterranean formation which consists in progressively removing the fine material displaced by the boring head as the latter is advanced so as to leave a pack of coarser material, such as gravel, around the external surface of the screening tube to serve as a screening medium.

The invention also comprises a method of conserving water supplies which con-

sists in transferring water from a surface or other water bearing stratum from which the water would ordinarily be lost by flow or evaporation or other causes to a deeper stratum in which it may be conserved for use and is characterised by the utilisation of a part of the head between the two strata for generating a supply of power.

Apparatus for carrying out this method comprises a collecting pipe in the surface or other stratum from which the water is to be transferred, a delivery pipe conveying the water from such collecting pipe to a shaft by which the water is conveyed to the lower stratum and a water turbine or like apparatus arranged at some point in the path of the water delivered to said shaft for generating a supply of electric power.

The invention also consists in the further features hereinafter described or indicated.

In carrying the invention into effect in one convenient manner a hollow vertical shaft of relatively large diameter and open at both ends is sunk into the ground, and when the shaft has been sunk to the required depth the bottom thereof is sealed by, for example, a layer of concrete and any water which may have collected in the shaft during the sinking operation is removed therefrom by pumping for instance.

The shaft may be built up in sections and may be lined with iron, concrete or other material which serves to strengthen and increase the weight of the shaft to facilitate the sinking thereof and the wall of the shaft is provided with one or more circumferential rows of openings, each row being preferably disposed in a plane perpendicular to the axis of the shaft, and the openings in one row being preferably arranged in staggered relationship with respect to the next row.

Each shaft opening is closed when the shaft is being sunk by, for instance, a plug or block which can be pushed out when it is desired to open up communication between the shaft and the neighbouring stratum, such, for instance, as gravel and sand, by means of collecting or distributing heads of relatively small diameter which are projected laterally through the openings in the shaft so as to radiate from the centre of the latter and extend into the stratum or strata from which it is desired to obtain water or which it is desired to replenish or supply with water.

Each such head consists of an outer longitudinally perforated tube which may be built up from sections coupled together from the inside of the shaft, by having screwed connections with each other for instance, and the forward end of such tube carries a boring head which is preferably of generally hollow conical formation and is slotted to permit fine material, such as sand, to enter the interior of the boring head during the boring operation.

The boring head may have a series of circumferential slots near the pointed end thereof each of which slots may extend lengthwise of the boring head and be bounded upon each longitudinal side with a sharp longitudinal projecting ridge provided upon the outside surface of the boring head. At its ends each ridge is reduced to the general level of the outer surface of the head by a gradual taper or slope. These ridges besides assisting in the boring operation also serve to lift the stones encountered during the boring operation and permit the fine material, such as sand, to pass freely through the slots into the interior of the boring head. The slots in the boring head may be formed with their side walls inclined so that the slots gradually widen from the outside of the boring head towards the inside thereof and also from the ends thereof next to the pointed end of the boring head towards the ends thereof remote from the said pointed end. The purpose of the former inclination of the longitudinal sides of the slots is to facilitate the passage of the fine material into the interior of the boring head while the purpose of the latter inclination of these sides of the slots is to promote a passage of any stones which may lodge within the slots along the latter towards the wide end of the slots where the stones encounter an inclined surface provided at this end of each slot and which surface tends to lift the stones out of the way as the boring head is advanced. The boring head may also be formed with a further series of circumferential longitudinal slots nearer to the wide end of the boring head than the other slots and staggered with relation thereto. At the lower end of each of these further slots there is provided a ridge projecting outwardly from the general level of the outer surface of the head, the side of the ridge facing towards the point of the head being formed as a gradual incline with respect to the surface of the head. This ridge serves to lift the gravel as the boring head is advanced and so promote a free passage of the sand through the top slots. The high end of each of these slots may also be formed at the top thereof with an inclined surface which tends to lift any stones which may lodge within the slots and which encounter this inclined surface as the boring head is advanced. Water will

also flow into the boring head with the fine material and during the projection of the perforated tube an imperforate tube is accommodated within and coaxial with the latter. This interior imperforate tube, which may also be built up from sections, is detachably connected at its forward end with the interior of the boring head while its rear end extends into the central shaft into which the sand and water is discharged from the said tube during the boring operation and pumped to the surface. This imperforate tube therefore serves for the removal of the fine material and the water (sand and water) which enters the boring head during the boring operation and when the boring operation has been completed, which will be when a sufficient length of perforated tube has been projected from the central shaft, the imperforate interior tube is disconnected from the boring head and is withdrawn from the perforated tube which is then open to receive a full supply of water from the surrounding stratum for discharge to the surface by a suitable pump located, for example, within the shaft, or to receive water from the surface for discharge into the neighbouring stratum.

If, during the projecting operation, the mouth of the boring head becomes clogged with clay or stones, for example, or if it is desired to wash the gravel or like material, or if an obstruction is encountered, a jet of water may be forced through the imperforate tube and the slots in the boring head.

If the head of water in the ground above the boring head is not sufficient to maintain an automatic inflow of the sand and water along the said interior tube the latter may be attached, at its rear end within the shaft, to a suction pump preferably through the medium of a driving head within the shaft which operates to impose the necessary force upon the boring head to perform the boring operation. Such driving head may consist of a block having a central bore communicating at one end with the rear end of the sand discharge tube and at its other end with another bore formed within the block and opening to the side of the block where connection is made with the vacuum pump for the discharge of the sand and water. Preferably the rear end of the sand discharge pipe is connected to a sleeve which has a sliding fit within the said block and an annular resilient ring or buffer is provided between the rear end of this sleeve and a flange formed within the block whereby a fluid tight joint is always maintained between the sand discharge tube and the vacuum pump. The said block of the driving head may be rotatable in order to vary the angle at which the sand and water is delivered therefrom to the vacuum pump.

An annular chamber is formed between the interior sand discharge tube and the exterior perforated screening tube which chamber serves to accommodate a packing sleeve which, during the boring operation, maintains a fluid tight joint between the perforated tube and the interior of the shaft and thus ensures that the full head of water outside the shaft may be utilised to flush the sand from the boring head through the interior discharge tube into the shaft for subsequent removal therefrom.

This packing sleeve may be slidably mounted upon the outside of the sand discharge tube and be provided on its outer periphery with one or more resilient rings, of rubber for instance, disposed longitudinally of the sleeve within annular recesses thereon, the rings being held in these recesses by means of wire, for example, wound tightly around the outer periphery of a portion of each ring which is of reduced diameter and which reduced portion is followed by an outwardly flared free portion the external diameter of which is normally greater than the internal diameter of the perforated tube so that this free portion engages tightly along its outer peripheral surface with the inside of the perforated tube. The outwardly flared free portions of the resilient rings upon the sliding packing sleeve are directed towards the forward end of the collecting or discharge head, and the arrangement is such that, when building up each collecting or discharge head from sections of perforated and imperforate tubes as each set of sections is secured to the previously projected set, the packing sleeve together with the resilient rings carried thereby can be retracted along the previously projected imperforate tube section so as to engage with the new set of tube sections within the central shaft.

The sliding packing sleeve, at its forward end, may be fitted with a further resilient ring, of rubber for example, which has an inwardly directed free hollow conical portion adapted to maintain a fluid tight joint with the sand tube. The perforated and imperforate tubes, together with the sliding packing sleeve thereon, may be passed through stuffing boxes provided around the shaft openings, and such stuffing boxes may each be fitted with an internal resilient ring having a forwardly directed free conical portion adapted to engage tightly with the exterior of the perforated tube as the same

is projected through its shaft opening and thereby seal the interior of the shaft against the ingress of water thereinto from the neighbouring stratum outside the shaft. Each stuffing box may consist of a sleeve which, at its forward end is screwed into a sleeve projecting slightly beyond each shaft opening and is secured to the latter by welding for example and this second sleeve may be fitted with a screw plug which is ejected from the sleeve by engagement of the boring head therewith when the latter is projected at the commencement of the boring operation. The sleeve of the stuffing box may be formed in two parts connected together by an outer collar so as to grip between them the said packing ring. By providing for the maintenance of fluid tight joints between the moving parts of each collecting or discharge head it is ensured that the full head of the water outside the shaft is utilised to flush the sand from the boring head through the sand discharge tube and into the interior of the shaft. When a perforated screening tube has been projected to the desired extent, the sand discharge tube associated therewith is disconnected from the boring head, and withdrawn from the perforated screening tube which may then be flushed and back-washed to remove therefrom, and from the gravel surrounding the outside of the screening tube, any remaining sand, so as to leave a gravel pack around the outside of the screening tube which may effectively admit the incoming water.

The rear end of each perforated tube is provided with a valve whereby the flow of the water along each such tube can be independently controlled and each such tube is also fitted with a pipe by which water may be supplied to the interior of the perforated tube in order to back-wash the same when it is desired to cleanse the screening tube after the removal of the sand discharge tube. Each valve may be arranged to be controlled by an upwardly extending operating spindle which is accessible from a stage or platform within the shaft and each back-wash water pipe, which may be removable, may also extend upwardly within the shaft and through such platform into the portion of the shaft above it.

When boring into exceptionally fine material, such as running sand, it is desirable to provide a valve within the boring head which closes to prevent ingress of sand into the water supply when the sand discharge tube has been withdrawn from the screening tube. Under such conditions, during the boring operation, the forward end of the sand discharge tube may be formed to project into the interior of the boring head where it holds a valve within the latter open, against the action of a spring, in order to permit the sand and water to flow through the discharge tube during such operation. This valve may consist of a plate pivoted to the inside of the hollow interior of the boring head and when the sand discharge pipe is withdrawn the valve automatically closes, by the action of its spring, the opening within the boring head by which the latter may have communication with the sand discharge tube.

The forward end of the sand discharge tube may be formed with an externally screw-threaded portion for engagement with an internally screw-threaded bore at the wide end of the boring head and which bore communicates with the hollow interior of the boring head. This bore may be provided within an extension of the wide end of the boring end which is of reduced diameter compared with such wide end and this extension may be screw-threaded externally to receive a correspondingly threaded portion on the forward end of the perforated screening tube, which, when screwed in position upon the boring head, may abut against the peripheral portion of the wide end of the boring head which projects beyond such extension. The external diameter of the perforated screening tube is preferably of less diameter than that of the wide end of the boring head in order that friction upon this tube may be relieved.

In some cases, particularly when boring into fine sand, the screening tube may be provided within another screening tube having fine slots or slits longitudinally thereof and preferably in staggered relationship.

When it is desired to obtain water from or deliver water to porous or fissured rock channels or tunnels are made in the material radiating, for example, from a central shaft sunk into the ground and each such channel or tunnel is provided at the end thereof adjacent to the shaft with a valve whereby the flow of water through each channel may be independently controlled, if necessary, through the medium of a pressure or vacuum pump according to whether it is desired to supply water to or deliver water from the channels. When recharging the subterranean formations with apparatus according to the invention the water supply may be filtered, by passing through sand filters for example, and conducted to the central shaft down which the water is allowed to flow for discharge through the lateral discharging heads under its own head, the water passing rapidly into the

porous subterranean formations on account of the large distributing area provided by the apparatus. Should silt be carried into the gravel adjacent to the screens, the upper water supply is shut off and the system is allowed to produce for a time and this may be assisted by allowing a pulsating motion of the water within the screens which removes the silt.

In cases where there is a bed of saturated sand or gravel near the ground surface, screen pipes may be pushed out into this bed and the water allowed to pass down the central shaft into lower screens within the deeper gravel beds so as to by-pass the impervious clay bed or beds usually present above the deeper gravel beds.

Water delivered from the subterranean formations by the installations and methods according to this invention is clear, since it is already filtered by passage through the subterranean gravel and sand, while surface pollution is impossible since a seal is placed around the shaft above the water producing stratum and adjacent to an impervious clay bed so that there can be no vertical communication between the collecting heads and the surface.

Where it is desired to obtain water from a river, a shaft is sunk near to the river and collecting heads are pushed out into the gravel beds beneath the river bed with the result that clear filtered water is obtained. Should the bed of the river be silty then the collecting heads may be back-washed periodically so that the fine material above the heads is washed upwards into the river and carried away thereby while the gravel settles down and forms a gravel pack around the perforated collecting heads.

When back-washing the collecting heads there is a surge of water in a direction opposite to the normal water flow which re-arranges the fine particles lodged among the grains around or within the perforations in the collecting heads so that the same pass readily into the shaft when the normal water flow resumes.

As above indicated, apparatus according to the invention may be employed for the purpose of replenishing or supplying subterranean formations with water.

The invention contemplates using a part of the head of water between the supply source and the point of discharge to the subterranean formations in order to generate a supply of power.

For instance, according to the invention, water may be transferred from a surface or other water bearing stratum from which the water would ordinarily be lost by flow or evaporation or other causes to a deeper stratum in which it may be conserved for use and in transferring this water a part of the head between the two strata is utilised to generate a supply of electrical power.

This may be achieved by forming the central shaft with openings adjacent to the strata between which a transfer of water is to take place and by projecting a collecting head, or series thereof, through the upper shaft openings into the upper stratum and a discharge head, or series thereof, through the lower shaft openings into the lower stratum. The collecting head delivers water to a pipe which extends downwardly within the shaft to a water turbine therein for generating a supply of electric power and from which turbine the water is discharged into the lower portion of the shaft for delivery through the discharge head, or heads, into the lower stratum.

Dated this 23rd day of July, 1934.
MARKS & CLERK.

COMPLETE SPECIFICATION

Method of and Apparatus for Recovering Fluids from or Supplying Fluids to Subterranean Formations

I, Leo Ranney, a citizen of the United States of America, of Petrolia, Ontario, Canada, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to apparatus adapted to be projected into the ground for recovering fluids from subterranean formations or for replenishing or supplying the subterranean formations with fluids.

The invention consists in apparatus adapted to be projected into the ground comprising, in combination, a chamber which is sunk into the ground and has an opening for affording communication between the interior and the exterior of the chamber, a perforated pipe adapted for axial sliding movement in the chamber opening for projection from the exterior of the chamber, and sealing means associated with the chamber opening adapted to maintain a fluid-tight joint with the pipe.

The invention also consists in apparatus for recovering fluids from or for supplying fluids to a subterranean formation comprising, in combination, a chamber extending into the formation and having a plurality of closable openings for affording communication between the interior of the chamber and the formation, a perforated pipe for each chamber opening adapted for axial insertion in the opening for projection therethrough by a sliding motion, a perforated boring head at the forward end of each pipe, the perforations in which head and in the pipe by rejecting the passage of oversize material cause this material to accumulate around the exterior of the pipe along the length thereof and means affording a seal between the exterior of each pipe and its chamber opening, the fluid passing through the interior of the pipe.

The invention also consists in a method of obtaining a fluid from or for supplying a fluid to a subterranean formation which consists in sinking a chamber into the formation, projecting a perforated pipe, having a perforated boring head at its forward end, by a sliding movement through an opening in the chamber wall into a gravel stratum so that a gravel pack forms along the length of the pipe on the exterior surface thereof and while maintaining a seal between the exterior surface of the pipe and the chamber opening to prevent passage of the fluid thereby, and withdrawing or supplying the fluid through the interior of the pipe.

In the accompanying drawings:

Figure 1 is a diagrammatic sectional view of an apparatus according to the invention,

Figure 2 is a plan of Figure 1,

Figure 3 is a fragmentary part sectional view of a detail of Figure 1 on an enlarged scale,

Figure 4 is a longitudinal section on an enlarged scale of a detail of the apparatus,

Figures 5 and 5ª are fragmentary longitudinal sections of the collecting or discharge pipes employed in the installation according to Figure 1,

Figures 6 to 9 are views of the improved boring head provided in accordance with the invention,

Figure 10 is a somewhat diagrammatic view of a modified installation according to the invention and

Figures 11 and 12 illustrate further details.

In carrying the invention into effect in one convenient manner, as illustrated in the drawings, a hollow vertical chamber or shaft 1 of relatively large diameter and open at both ends is sunk into the ground, and when the chamber has been sunk to the required depth the bottom thereof is sealed by, for example, a layer of concrete 2 and any water which may have collected in the chamber during the sinking operation is removed therefrom by pumping for instance.

The chamber may be built up in sections and may be lined with iron, concrete or other material which serves to strengthen and increase the weight of the chamber to facilitate the sinking thereof and the wall of the chamber is provided with one or more circumferential rows of openings 3, each row being preferably disposed in a plane perpendicular to the axis of the chamber, and the openings in one row being preferably arranged in staggered relationship with respect to the next row.

Each chamber opening is closed when the chamber is being sunk by for instance, a plug or block 4 which can be pushed out when it is desired to open up communication between the chamber and the neighbouring stratum, such. for instance, as gravel and sand, by means of collecting or distributing heads 5 of relatively small diameter which are projected laterally through the openings in the chamber so as to radiate from the centre of the latter and extend into the stratum or strata from which it is desired to obtain water or which it is desired to replenish or supply with water.

Each such head consists of an outer longitudinally perforated tube 6 (Figures 5 and 5ª) which may be built up from sections coupled together from the inside of the shaft, by having screwed connections with each other for instance, and the forward end of such tube carries a boring head 7 (Figures 4, 6 to 9 and 11) which is preferably of generally hollow conical formation and is slotted to permit fine material, such as sand, to enter the interior of the boring head during the boring operation.

The boring head may have a series of circumferential slots 8 near the pointed end thereof each of which slots may extend lengthwise of the boring head and be bounded upon each longitudinal side with a sharp longitudinal projecting ridge 9 provided upon the outside surface of the boring head. At its ends each ridge is reduced to the general level of the outer surface of the head by a gradual taper or slope 10. These ridges besides assisting in the boring operation also serve to lift the stones encountered during the boring operation and permit of the fine material, such as sand, to pass freely through the slots 8 into the interior of the boring head. The slots in the boring

head may be formed with their side walls 11 (Figures 8 and 9) inclined so that the slots gradually widen from the outside of the boring head towards the inside thereof and also from the ends thereof next to the pointed end of the boring head towards the ends thereof remote from the said pointed end. The purpose of the former inclination of the longitudinal sides of the slots 8 is to facilitate the passage of the fine material into the interior of the boring head while the purpose of the latter inclination of these sides of the slots is to promote a passage of any stones which may lodge within the slots along the latter towards the wide end of the slots where the stones encounter an inclined surface 12 (Figure 6) provided at this end of each slot and which surface tends to lift the stones out of the way as the boring head is advanced. The boring head may also be formed with a further series of circumferential longitudinal slots 13 (Figure 7) nearer to the wide end of the boring head than the other slots and staggered with relation thereto. At the lower end of each of these further slots there is provided a ridge 14 projecting outwardly from the general level of the outer surface of the head, the side of the ridge facing towards the point of the head being formed as a gradual incline with respect to the surface of the head. This ridge serves to lift the gravel as the boring head is advanced and so promote a free passage of the sand through the top slots. The high end of each of these slots 13 may also be formed at the top thereof with an inclined surface 14[a] which tends to lift any stones which may lodge within the slots and which encounter this inclined surface as the boring head is advanced.

Water will also flow into the boring head with the fine material and during the projection of the perforated tube 6 an imperforate tube 15 is accommodated within and coaxial with the latter. This interior imperforate tube 15, which may also be built up from sections, is detachably connected at its forward end with the interior of the boring head 7 while its rear end extends into the central shaft 1 into which the sand and water is discharged from the said tube during the boring operation and pumped to the surface. This imperforate tube therefore serves for the removal of the fine material and the water (sand and water) which enters the boring head during the boring operation and when the boring operation has been completed, which will be when a sufficient length of perforated tube 6 has been projected from the central shaft, the imperforate interior tube 15 is disconnected from the boring head 7 and is withdrawn from the perforated tube which is then open to receive a full supply of water from the surrounding stratum for discharge to the surface by a suitable pump located, for example, within the shaft, or to receive water from the surface for discharge into the neighbouring stratum.

If, during the projecting operation, the mouth of the boring head becomes clogged with clay or stones, for example, or if it is desired to wash the gravel or like material, or if an obstruction is encountered, a jet of water may be forced through the imperforate tube and the slots in the boring head.

If the head of water in the ground above the boring head 7 of each header unit 5 is not sufficient to maintain an automatic inflow of the material (sand and water) along the inner pipe the latter may be attached, at its rear end within the chamber, to a suction pump preferably through the medium of a driving head within the chamber which operates to impose the necessary force upon the boring head to perform the boring operation. Such driving head may consist of a block 16 (Figure 12) having a central bore 17 communicating at one end with the rear end of the inner discharge pipe and at its other end with another bore 18 formed within the block and opening to the side of the block where connection is made with the vacuum pump (not shown) for the discharge of the material from the inner pipe. Preferably the rear end of this inner pipe is connected to a sleeve 19 which has a sliding fit within the said block and an annular resilient ring or buffer 20 is provided between the rear end of this sleeve and a flange 21 formed within the block whereby a fluid tight joint is always maintained between the pipe and the vacuum pump. The said block of the driving head may be rotatable in order to vary the angle at which the material is delivered therefrom to the vacuum pump.

An annular chamber 22 is formed between the interior sand discharge tube 15 and the exterior perforated screening tube 6, which chamber serves to accommodate a packing sleeve 23 (Figures 5 and 5[a]) which, during the boring operation, maintains a fluid tight joint between the perforated tube and the interior of the shaft and thus ensures that the full head of water outside the shaft may be utilised to flush the sand from the boring head through the interior discharge tube into the shaft for subsequent removal therefrom.

This packing sleeve may be slidably

mounted upon the outside of the sand discharge tube and be provided on its outer periphery with one or more resilient rings 24, of rubber for instance, disposed longitudinally of the sleeve within annular recesses 25 thereon, the rings being held in these recesses by means of wire 26, for example, wound tightly around the outer periphery of a portion of each ring which is of reduced diameter and which reduced portion is followed by an outwardly flared free portion 24^b the external diameter of which is normally greater than the internal diameter of the perforated tube so that this free portion engages tightly along its outer peripheral surface with the inside of the perforated tube. The outwardly flared free portions 24^b of the resilient rings upon the sliding packing sleeve are directed towards the forward end of the collecting or discharge head, and the arrangement is such that, when building up each collecting or discharge head from sections of perforated and imperforate tubes as each set of sections is secured to the previously projected set, the packing sleeve together with the resilient rings carried thereby can be retracted along the previously projected imperforate tube section so as to engage with the new set of tube sections within the central shaft.

The sliding packing sleeve at its forward end, may be fitted with a further resilient ring 27, of rubber for example, which has an inwardly directed free hollow conical portion 27^a adapted to maintain a fluid tight joint with the sand tube. The perforated and imperforate tubes, together with the sliding packing sleeve thereon, may be passed through stuffing boxes 28 (Figure 4) provided around the shaft openings 3, and such stuffing boxes may each be fitted with an internal resilient ring 29 having a forwardly directed free conical portion 29*a* adapted to engage tightly with the exterior of the perforated tube 6 as the same is projected through its shaft opening and thereby seal the interior of the shaft against the ingress of water thereinto from the neighbouring stratum outside the shaft. Each stuffing box may consist of a sleeve 28 which, at its forward end is screwed into a sleeve 30 projecting slightly beyond each chamber opening and is secured to the latter by welding for example and this second sleeve may be fitted with a screw plug 4 which is ejected from the sleeve by engagement of the boring head 7 therewith when the latter is projected at the commencement of the boring operation. The sleeve of the stuffing box may be formed in two parts 28, 28^a, connected together by an outer collar 28^b so as to grip between them the said packing ring 29. By providing for the maintenance of fluid tight joints between the moving parts of each collecting or discharge head it is ensured that the full head of the water outside the chamber is utilised to flush the sand from the boring head through the inner sand discharge pipe and into the interior of the chamber. When a perforated screening pipe 6 has been projected to the desired extent, the sand discharge pipe associated therewith is disconnected from the boring head, and withdrawn from the perforated screening pipe 6 which may then be flushed and backwashed to remove therefrom, and from the gravel surrounding the outside of the screening pipe, any remaining sand, so as to leave a gravel pack around the outside of the screening pipe which may effectively admit the incoming water.

The rear end of each perforated pipe 6 is provided with a valve 31 (Figure 1) whereby the flow of the water along each such pipe can be independently controlled and each such pipe is also fitted with a pipe 32 by which water may be supplied to the interior of the perforated pipe in order to backwash the same when it is desired to cleanse the screening pipe after the removal of the sand discharge pipe. Each valve 31 may be arranged to be controlled by an upwardly extending operating spindle 33 which is accessible from a stage or platform 34 within the shaft and each backwash water pipe 32, which may be removable, may also extend upwardly within the chamber and through such platform into the portion of the chamber above it.

When boring into exceptionally fine material, such as running sand, it is desirable to provide a valve 35 (Figure 6) within the boring head which closes to prevent ingress of sand into the water supply when the sand discharge tube has been withdrawn from the screening tube. Under such conditions, during the boring operation, the forward end 36 of the sand discharge tube may be formed to project into the interior of the boring head where it holds the valve 35 within the latter open, against the action of a spring 36^a, in order to permit the sand and water to flow through the discharge tube during such operation. This valve may consist of a plate pivoted at 35^a to the inside of the hollow interior of the boring head and when the sand discharge pipe is withdrawn the valve automatically closes, by the action of its spring, the opening within the boring head by which the

latter may have communication with the sand discharge tube.

The forward end of the sand discharge tube 15 may be formed with an externally screw-threaded portion 15^a (Figure 5^a) for engagement with an internally screw-threaded bore 15^b (Figure 6) at the wide end of the boring head and which bore communicates with the hollow interior of the boring head. This bore may be provided within an extension 37 of the wide end of the boring head which is of reduced diameter than that of such wide end and this extension may be screw-threaded externally, as indicated at 6^a, to receive a correspondingly threaded portion 6^b on the forward end of the perforated screening tube, which, when screwed in position upon the boring head, may abut against the peripheral portion 38 of the wide end of the boring head which projects beyond such extension. The external diameter of the perforated screening tube is preferably of less diameter than that of the wide end of the boring head in order that friction upon this tube may be relieved.

At one or more points along the wall of the discharge conduit there may be provided one or more portholes 65 (Fig. 11) which may be opened and closed at will, for example, by sliding the discharge conduit backwards or forwards.

In some cases, particularly when boring into fine sand, the screening tube may be provided within another screening tube 39 (Figures 5 and 5^a) having fine slots or slits longitudinally thereof and preferably in staggered relationship.

When it is desired to obtain water from or deliver water to porous or fissured rock channels or tunnels are made in the material radiating, for example, from a central chamber sunk into the ground and each such channel or tunnel is provided at the end thereof adjacent to the chamber with a valve 31 (Figure 1) whereby the flow of water through each channel may be independently controlled, if necessary, through the medium of a pressure or vacuum pump according to whether it is desired to supply water to or deliver water from the channels.

When recharging the subterranean formations with apparatus according to the invention the water supply may be filtered, by passing through sand filters for example, and conducted to the central chamber 1 down which the water is allowed to flow for discharge through the lateral discharging heads 5 under its own head, the water passing rapidly into the porous subterranean formations on account of the large distributing area provided by the apparatus. Should silt be carried into the gravel adjacent to the screens, the upper water supply is shut off and the system is allowed to produce for a time and this may be assisted by allowing a pulsating motion of the water within the screens which removes the silt.

In cases where there is a bed of saturated sand or gravel near the ground surface, screen pipes may be pushed out into this bed and the water allowed to pass down the central shaft into lower screens within the deeper gravel beds so as to by-pass the impervious clay bed or beds usually present above the deeper gravel beds.

Water delivered from the subterranean formations by the apparatus according to this invention is clear, since it is already filtered by passage through the subterranean gravel and sand, while surface pollution is impossible since a seal is placed around the shaft above the water producing stratum and adjacent to an impervious clay bed so that there can be no vertical communication between the collecting heads and the surface.

Where it is desired to obtain water from a river, a chamber or shaft 1 is sunk near to the river and collecting heads 5 are pushed out into the gravel beds beneath the river bed with the result that clear filtered water is obtained. Should the bed of the river be silty then the collecting heads may be backwashed periodically so that the fine material above the heads is washed upwards into the river and carried away thereby while the gravel settles down and forms a gravel pack around the perforated collecting heads.

When backwashing the collecting heads there is a surge of water in a direction opposite to the normal water flow which re-arranges the fine particles lodged among the grains around or within the perforations in the collecting heads so that the same pass readily into the chamber when the normal water flow resumes.

As above indicated, apparatus according to the invention may be employed for the purpose of replenishing or supplying subterranean formations with water.

The invention contemplates using a part of the head of water between the supply source and the point of discharge to the subterranean formations in order to generate a supply of power.

For instance, according to the invention, water may be transferred from a surface or other water bearing stratum from which the water would ordinarily be lost by flow or evaporation or other causes to a deeper stratum in which it

may be conserved for use and in transferring this water a part of the head between the two strata is utilised to generate a supply of electrical power.

This may be achieved by forming the central chamber 1 with openings adjacent to the strata between which a transfer of water is to take place and by projecting a collecting head 55 (Figure 6), or series thereof, through the upper chamber openings into the upper stratum and a discharge head, or series thereof, through the lower chamber openings into the lower stratum. The collecting head delivers water to a pipe 56 which extends downwardly within the chamber to a water turbine therein for generating a supply of electric power and from which turbine the water is discharged into the lower portion of the chamber for delivery through the discharge head 57, or heads, into the lower stratum.

Reference is directed to the fact that the boring apparatus per se forms the subject of my other Application No. 31715 of 1935.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. Apparatus adapted to be projected into the ground comprising, in combination, a chamber which is sunk into the ground and has an opening for affording communication between the interior and the exterior of the chamber, a perforated pipe adapted for axial sliding movement in the chamber opening for projection outwardly from the chamber, and sealing means associated with the chamber opening adapted to maintain a fluid-tight joint with the pipe.

2. Apparatus according to Claim 1 wherein the said opening during sinking of the chamber is closed by a plug which is ejected outwardly by the action of pushing the pipe through the opening.

3. Apparatus according to Claim 1 or 2 wherein an inner imperforate pipe is provided within the perforated pipe which imperforate pipe at one end thereof communicates with the forward end of the perforated pipe or with the interior of a boring head secured to the forward end of the perforated pipe and at its opposite end extends into the interior of the chamber.

4. Apparatus according to Claim 3 wherein means is provided at the inner end of the imperforate pipe connecting this pipe with a suction source to facilitate the flow of matter along the pipe.

5. Apparatus according to Claim 4 wherein the interior of the imperforate pipe is connected with the suction source through the medium of a ported block which operates to impose the necessary force to project the combined pipes.

6. Apparatus according to any of the Claims 1 to 5 wherein the said sealing means comprises a sleeve secured within the chamber opening and fitted with an internal resilient ring having a forwardly projecting free portion which engages tightly with the outer pipe to maintain a fluid-tight joint therewith.

7. Apparatus according to any of the Claims 1 to 6 wherein the perforated pipe has an extension within the chamber fitted with a valve for controlling the flow of matter through this pipe.

8. Apparatus according to any of the Claims 1 to 7 wherein a pipe within the chamber is connected with the perforated pipe and serves to supply water to the interior of this pipe to cleanse the same and the filter bed surrounding this pipe.

9. Apparatus according to any of the Claims 1 to 8 comprising an upper perforated pipe and a lower such pipe by which water may be conveyed through the chamber from one earth level to the other.

10. Apparatus according to Claim 9 wherein means is provided within the chamber, a water turbine for example, in the path of the water delivered to the chamber from the upper pipe adapted to generate a supply of electrical energy.

11. Apparatus for recovering fluids from or for supplying fluids to a subterranean formation comprising, in combination, a chamber extending into the formation and having a plurality of closable openings for affording communication between the interior of the chamber and the formation, a perforated pipe for each chamber opening adapted for axial insertion in the opening for projection therethrough by a sliding motion, a perforated boring head at the forward end of each pipe, the perforations in which head and in the pipe by rejecting the passage of oversize material cause this material to accumulate around the exterior of the pipe along the length thereof and means affording a seal between the exterior of each pipe and its chamber opening, the fluid passing through the interior of the pipe.

12. Apparatus according to any of the Claims 1 to 4 and 6 to 11 wherein means is provided for applying to the outer pipe the force necessary to push the apparatus into the ground.

13. Apparatus according to any of the Claims 1 to 12 wherein the openings in the boring head are bounded on the out-

side of the head with longitudinal ridges.

14. Apparatus according to any of the Claims 1 to 13 wherein the inner pipe has a controllable opening by which the inner pipe may have communication with the interior of the outer pipe at will.

15. Apparatus according to any of the Claims 1 to 14 wherein the outer pipe is surrounded by a relatively thin tube having fine slots or slits.

16. Apparatus according to any of the Claims 1 to 15 wherein the side walls of the slots in the boring head are inclined so that the slots gradually widen in an inward direction and also in a longitudinal direction away from the tip of the boring head.

17. Apparatus according to any of the preceding Claims wherein a valve is fitted within the boring head which valve closes the interior of the head from communication with the outer pipe when the inner pipe is removed.

18. The method of obtaining a fluid from or for supplying a fluid to a subterranean formation which consists in singing a chamber into the formation, projecting a perforated pipe, having a perforated boring head at its forward end, by a sliding movement through an opening in the chamber wall into a gravel stratum so that a gravel pack forms along the length of the pipe on the exterior surface thereof and while maintaining a seal between the exterior surface of the pipe and the chamber opening to prevent passage of the fluid thereby, and withdrawing or supplying the fluid through the interior of the pipe.

Dated this 4th day of October, 1934.

MARKS & CLERK.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1936.

[This Drawing is a reproduction of the Original on a reduced scale.]

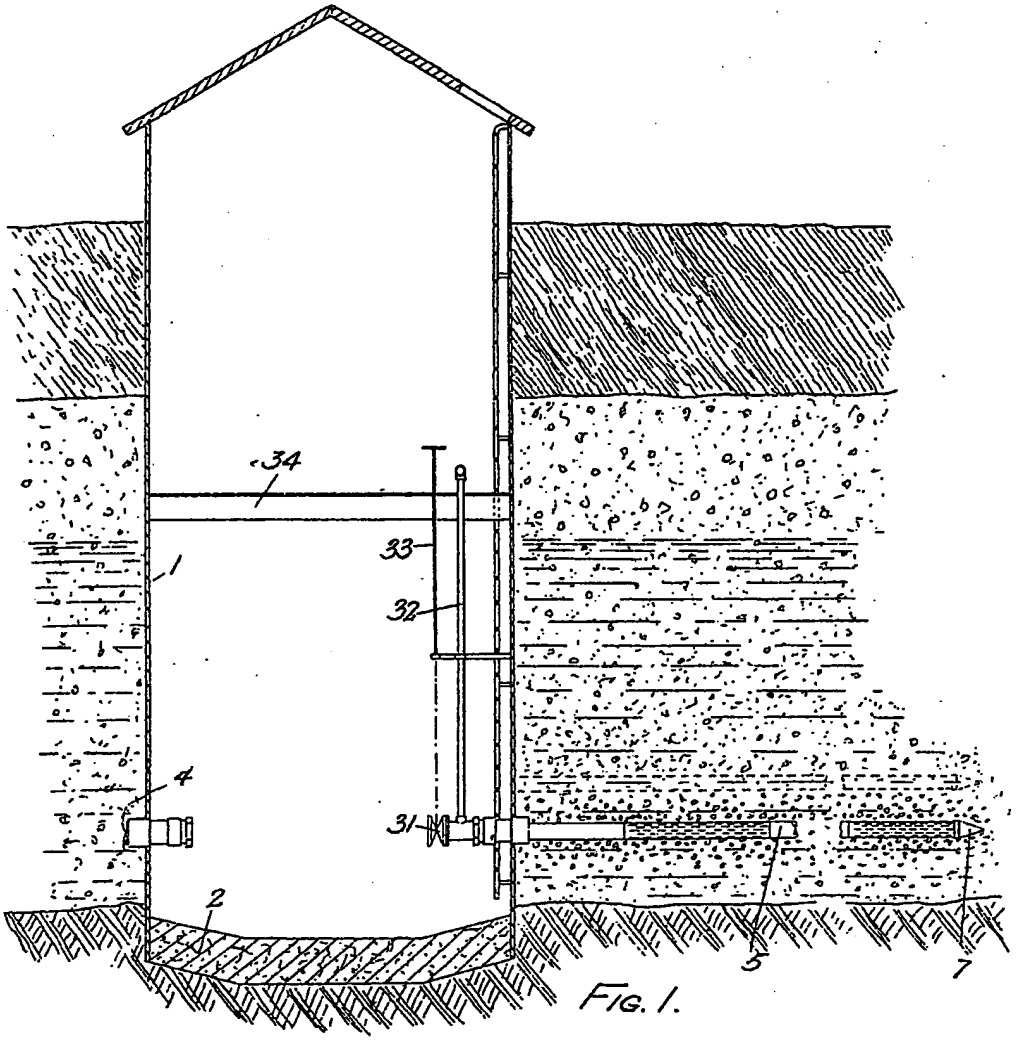


FIG. 1.

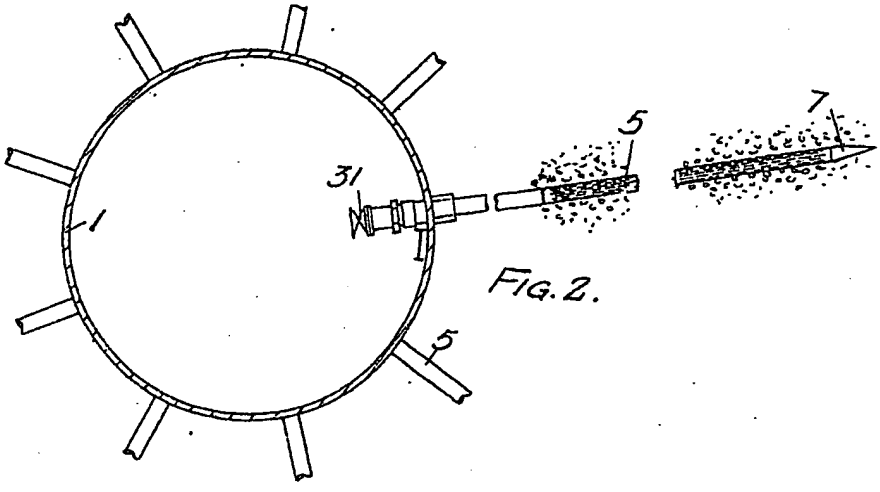
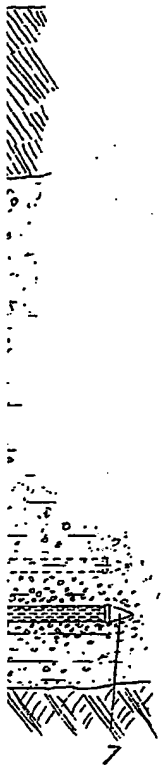


FIG. 2.



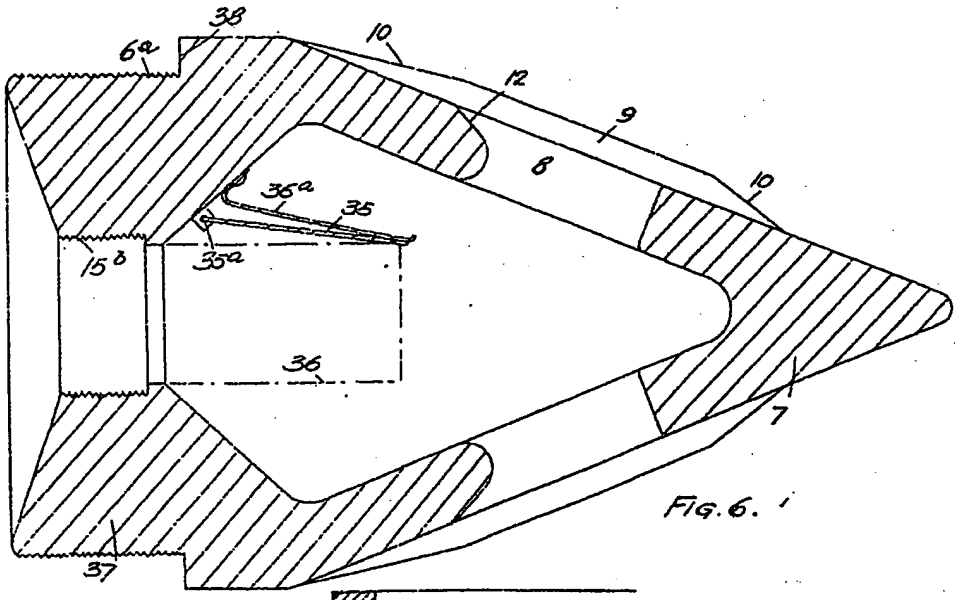


FIG. 6.

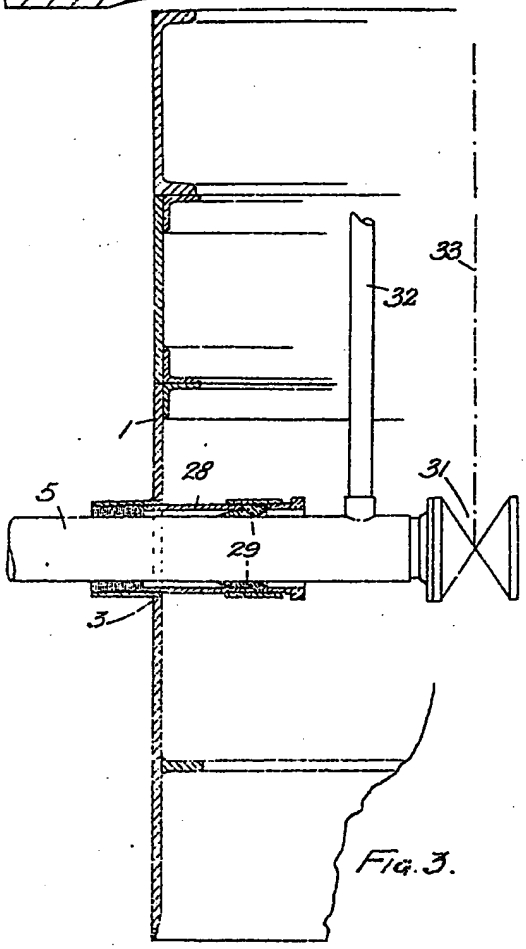


FIG. 3.

Malby & Sons, Photo-Lith.

442,008 COMPLETE SPECIFICATION

6 SHEETS

SHEET 1

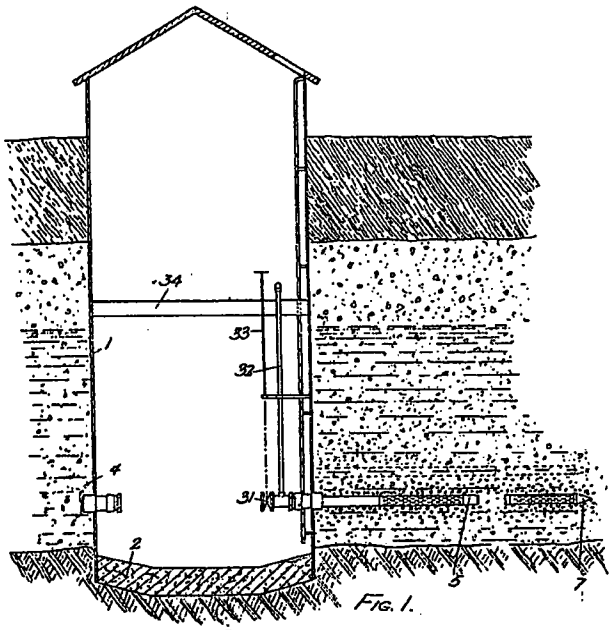


FIG. 1.

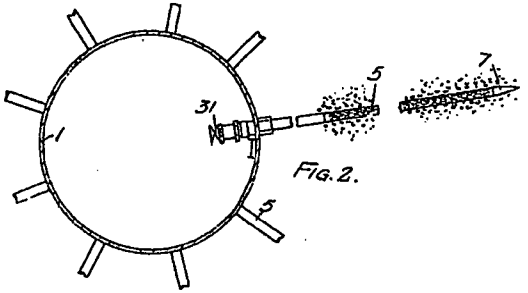


FIG. 2.

[This Drawing is a reproduction of the Original on a reduced scale.]

SHEET 2

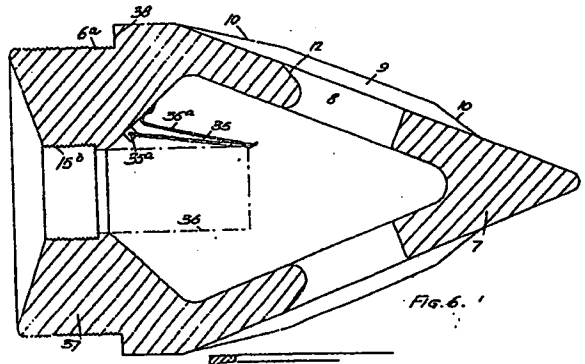


FIG. 6. 1

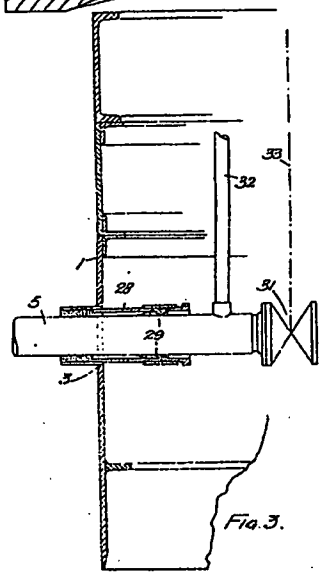


FIG. 3.

Malby & Sons, Photo-Lith

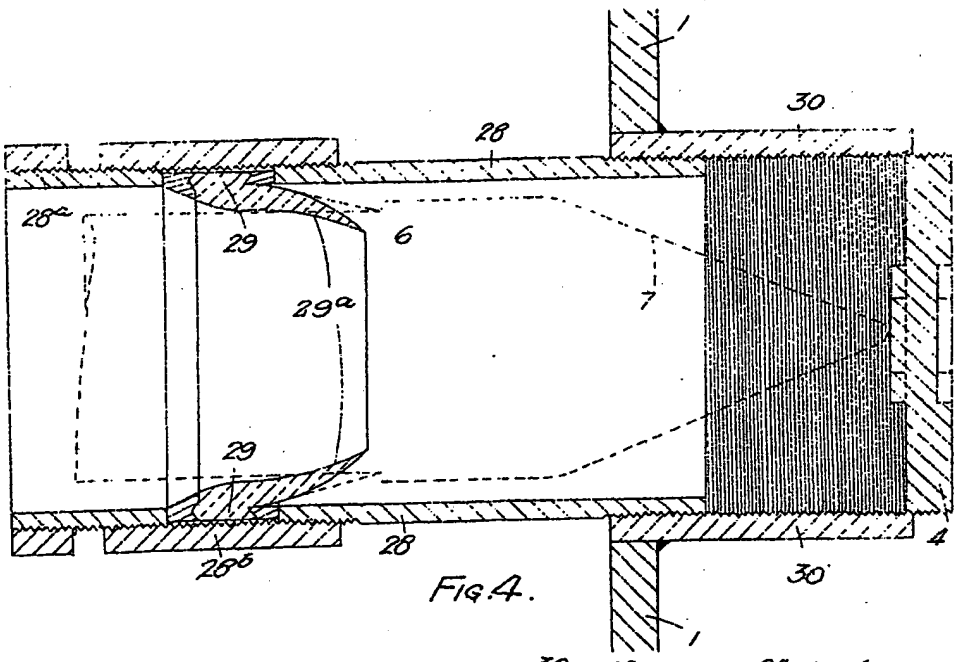


FIG. 4.

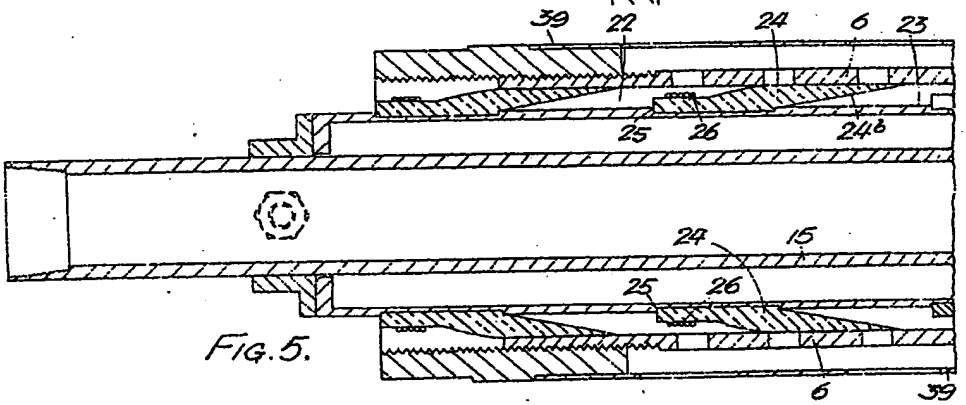


FIG. 5.

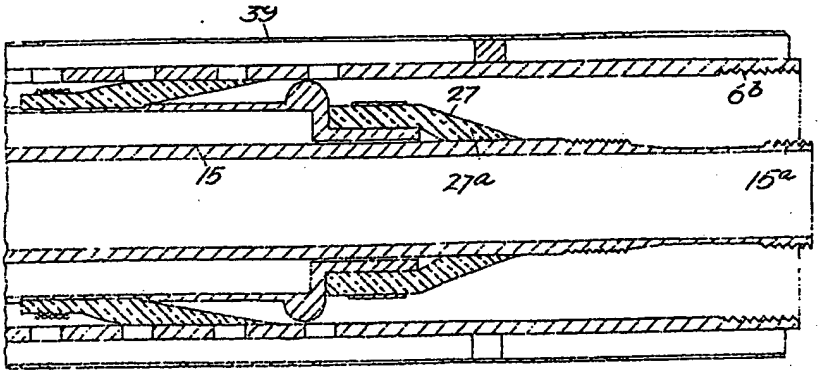
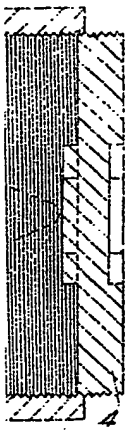
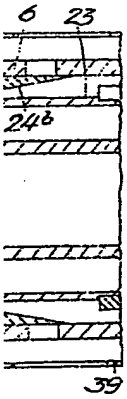
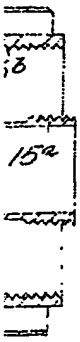


FIG. 5a.







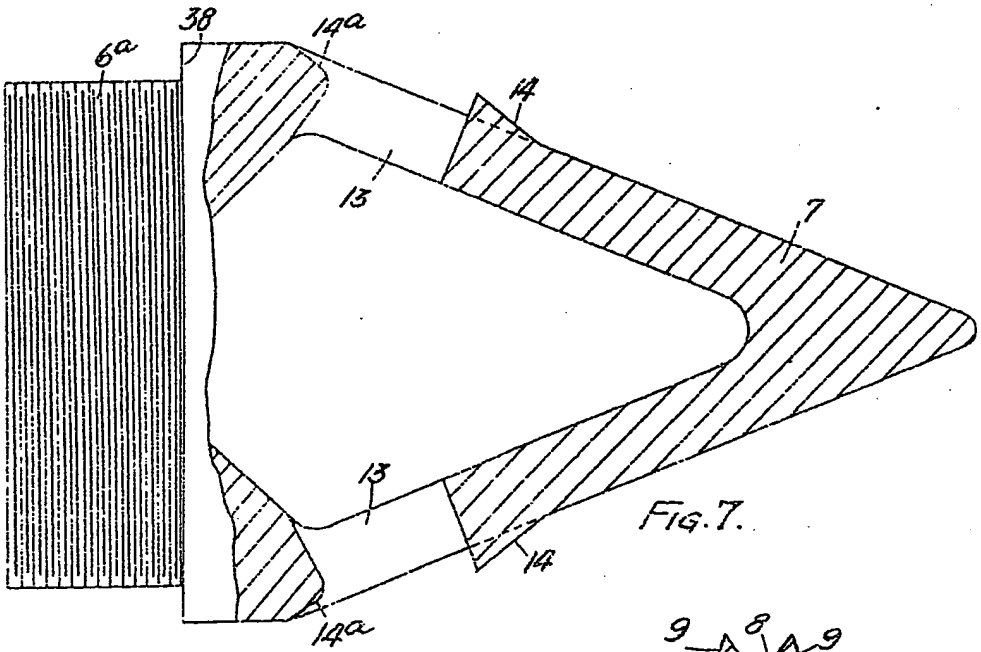


FIG. 7.

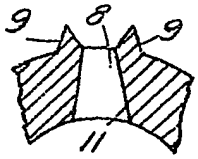


FIG. 9.

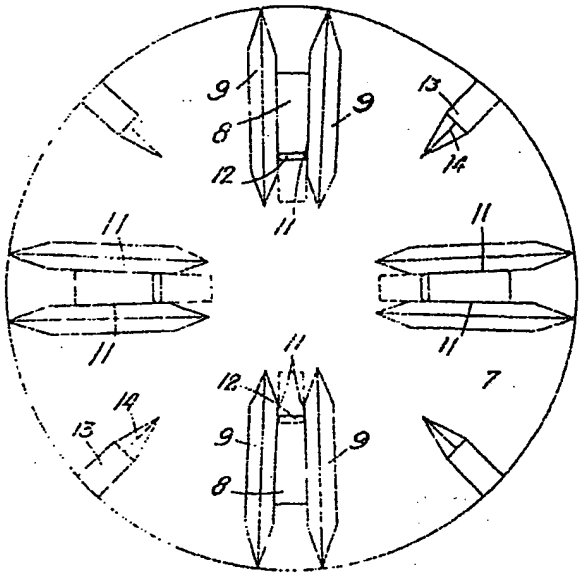


FIG. 8.

Malby & Sons Photo-Lith

442,008 COMPLETE SPECIFICATION

6 SHEETS

SHEET 3

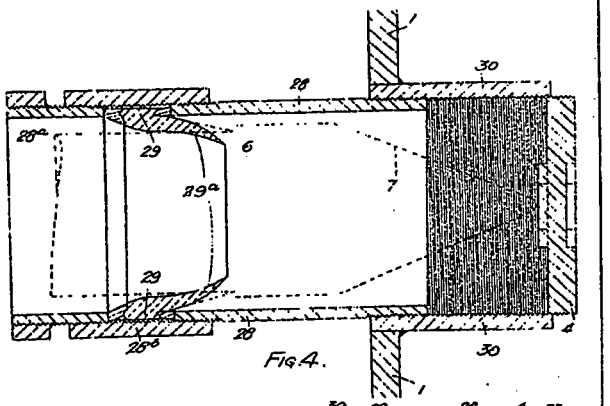


FIG. 4.

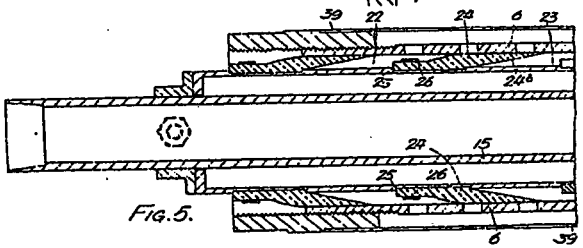


FIG. 5.

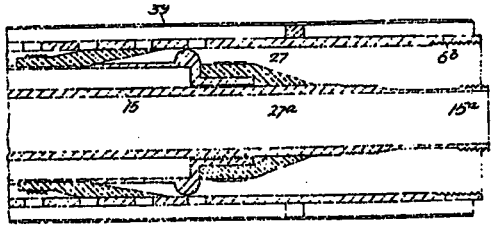


FIG. 5a.

SHEET 4

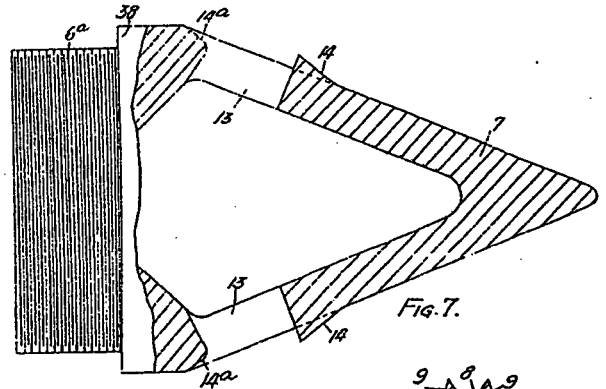


FIG. 7.

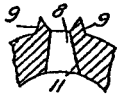


FIG. 9.

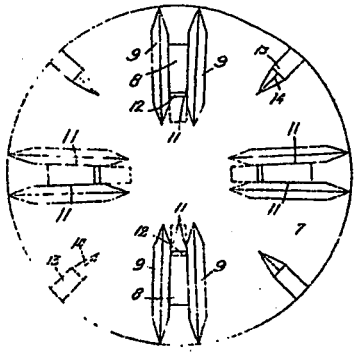


FIG. 8.

This Drawing is a reproduction of the Original on a reduced scale.

Malby & Sons Photo-Lith

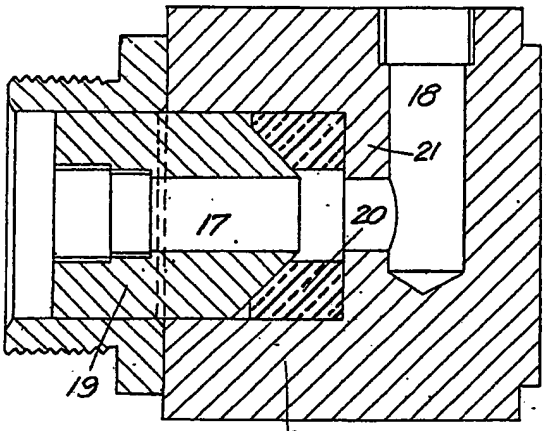
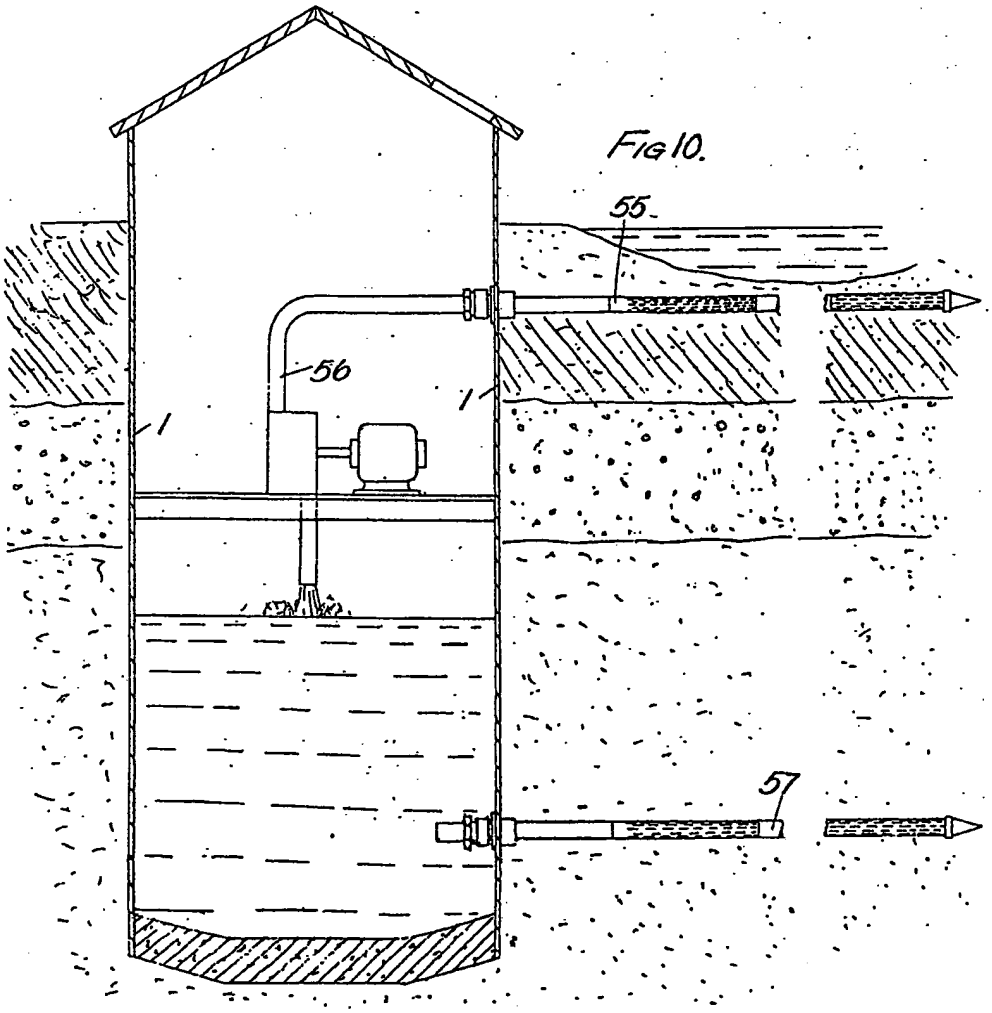
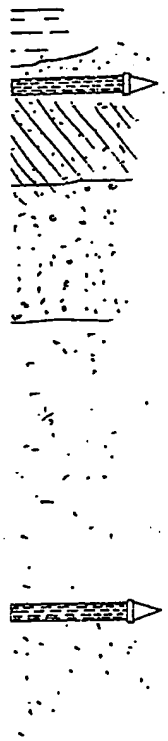


FIG. 12.

FIG 10.





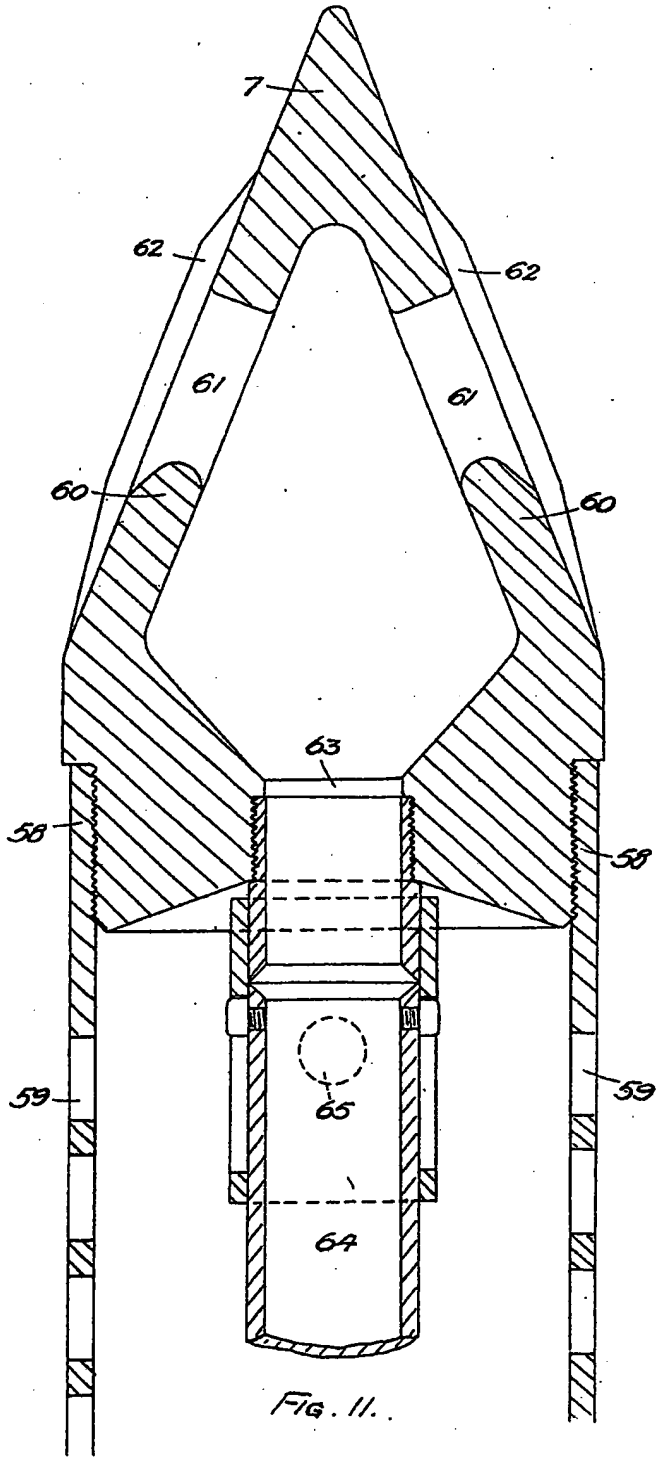


FIG. 11.

Melby & Sons, Photo-Lith

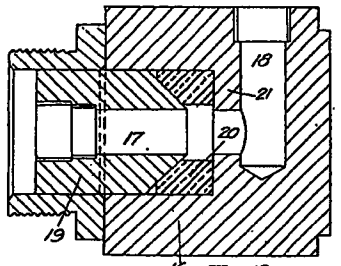


FIG. 12.

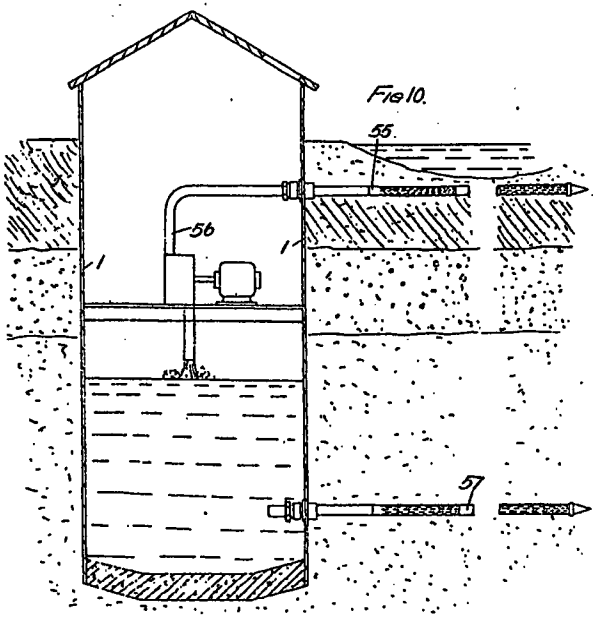


FIG 10.

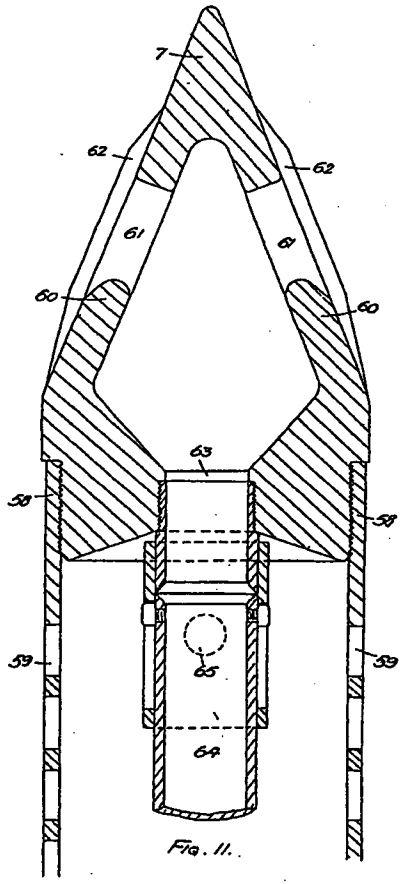


FIG. 11.

Malby & Sons, Photo-Lith